quantities. This is all that it purports to be.

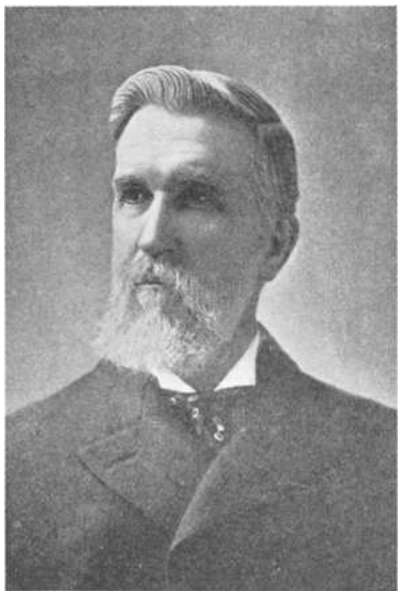
The same result comes as a first approximation from the virial theory, and from statistical theory. These latter methods are certainly the more elegant ones. There are advantages, however, in a theory which is more pictorial, especially when the picture is not too fictitious.

I am greatly indebted to Dr. Karl Herzfeld, whose thorough criticism of the first draft of this paper clarified my thinking in the matter considerably and led me to make several changes. He must not be held responsible, however, for any errors that there may be in the paper. Those I must cling to as my own.

The Untold Story of the Telephone

LLOYD W. TAYLOR
Department of Physics, Oberlin College, Oberlin, Ohio

ON December 13, 1934 the newspapers noted the death of Thomas A. Watson, the man who, as the assistant of Alexander Graham Bell, was the first American to understand a sentence spoken over the telephone. With his demise went the last survivor of a small group of men who had a first-hand, uncensored knowledge of the circumstances surrounding the birth of the telephone. Much of the story of that great discovery they have given to the world. Other portions of it which they have left untold are perhaps of equal interest. Some of these untold portions are of record, though the records are widely scattered and there has been a surprising lack of competent endeavor to bring them together and integrate them with the more publicized parts of the story. Some of the less well-known but more important portions are to be found in court and patent office records, in technical publications, in the proceedings of an investigating committee of the United States House of Representatives and in memoirs and personal correspondence of some of the principals. While it is unlikely that even the sum total of all these sources embodies the entire story of the telephone, it does bring out some points that place the publicized portions in a very different light than that in which they are commonly viewed.



Elisha Gray, as he appeared when he organized and presided at the first International Electrical Congress in Chicago in 1893. [From *The Electrical Journal*, Sept. 1, 1895.]

The prevailing tendency to attribute great inventions exclusively to single individuals may be natural. It is certainly fostered by the way in which our patent laws are formulated and administered, but it creates a major problem for those who are interested in historical and scientific accuracy. In the sciences allowance is regularly made for the possibility of independent discoveries, whether simultaneous or not, and there are many important chapters of science in which that element is prominent. The impossibility of sharing credit within the framework of our patent law creates a prolific source of distortions of historical fact. The identification of Alexander Graham Bell with the birth of the telephone, to the exclusion of all others, is one example of this tendency. As in many other instances, the Bell tradition greatly oversimplifies the actual circumstances. It had its birth in a skilful combination of truth and silence out of which has grown the mighty myth that Bell was primarily responsible for the invention of the telephone.

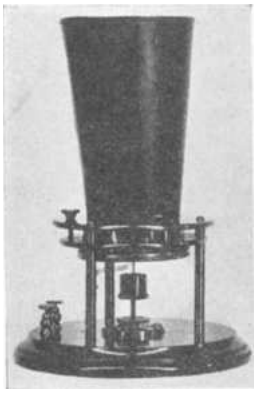


FIG. 1. The transmitter which Bell used on March 10, 1876.

More than sixty years have passed since the momentous day in March, 1876, when Bell spoke the first sentence ever transmitted in this country by electricity. That exclamation, "Mr. Watson, come here, I want you!" is justly celebrated as the beginning of a new era in communication. The episode is fully authenticated; nor is there any good reason to suppose that it was antedated in this country by any other successful attempt of the same kind. The story has been told many times by the participants themselves. The most recent account is to be found in Watson's autobiography.[1] He describes the occasion as follows:

> It was during one of Bell's experiments on this kind of a telephone that the first sentence was transmitted and understood. I had made for Bell a new transmitter [Fig. 1] in which a wire, attached to a diaphragm, touched acidulated water contained in a metal cup, both included in a circuit through the battery and the receiving telephone. The depth of the wire in the acid and consequently the resistance of the circuit was varied as the voice made the diaphragm vibrate, which made the galvanic current undulate in speech form.
>
> I carried the transmitter when finished to Exeter Place on the evening of March 10, 1876, intending to spend the night with Bell testing it. Neither of us had the least idea that we were about to try the best transmitter that had yet been devised. We filled the cup with diluted sulphuric acid, and connected it to the wire running between the two rooms. When all was ready I went into Bell's bedroom and stood by the bureau with my ear at the receiving telephone. Almost at once I was astonished to hear Bell's voice coming from it distinctly saying, "Mr. Watson, come here; I want you!" He had no receiving telephone at his end of the wire so I couldn't answer him, but as the tone of his voice indicated he needed help, I rushed down the hall into his room and found he had upset the acid of a battery over his clothes. He forgot the incident in his joy over the success of the new transmitter when I told him how plainly I had heard his words; and his joy was increased when he went to the other end of the wire and heard how distinctly my voice came through.

[1] *Exploring Life* (D. Appleton-Century, 1926), pp. 77–81.

There has never been any occasion for questioning the story as thus told by Watson. He and Bell have a clear priority to the claim of having conducted the first American telephone conversation. It is true that this story was not publicly told for several years after the event, but this was due, not to any suppression of it by opposing interests, but through the apparent intent of Bell himself. The most interesting feature of the episode is, however, the fact that Watson's account constitutes only a part of the story. There are some aspects of the story as a whole, now almost forgotten, which place it in an entirely different light than that in which it is customarily presented. For the entire story to have come to light would have been a catastrophe from Bell's point of view. Hence it may be that the delay in telling it arose from the necessity for waiting until the selection of certain portions of it and the discarding of others could be made with less danger of challenge.

Four of the most interesting elements in the setting of Watson's story which do not appear in that or any other of the official versions are the following:

First: that the transmitter into which Bell spoke on March 10, 1876 was a very different kind of instrument from that described and illustrated in his earlier patent.

Second: that the transmitter which he had constructed for the occasion had previously been described by a man named Elisha Gray in a confidential document about the

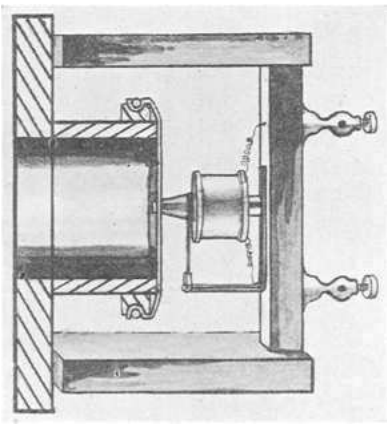


FIG. 2. Cross section of Bell's transmitter of 1875. Later used also as a receiver.

contents of which Bell subsequently acknowledged having received information.

Third: that it was not until four years later that Bell made any claim to the type of transmitter into which he spoke on that historic occasion.

Fourth: that Elisha Gray had made and publicly used several types of telephone receiver many months before Bell constructed his first one.

These theses may now be developed somewhat more fully. The first three deal with the microphone type of transmitter, which is now universally used, and the fourth with the metal-diaphragm type of receiver, equally common. Both are commonplaces today, but neither was a commonplace in 1876. The telephone controversy centers primarily in the transmitter.

The first point is, then, that *the transmitter into which Bell spoke on March 10, 1876, was a very different kind of instrument from that described and illustrated in his earlier patent.* Bell's exclamation to Watson had the great historical significance of being the first words of any American experimenter to be spoken into a microphone type of transmitter. Hence it was the first telephone conversation, if a one-way exclamation can be termed such, in which the prototype of the modern transmitter played a part.

Now Bell had already invented a telephone transmitter, and several months prior to his famous exploit of March, 1876, had made attempts to operate it.[2] A copy of the original, made under the direction of Bell himself, is in existence today. Fig. 2 is a drawing of the cross section, showing the instrument in position for use. During Bell's 1875 experiments, sounds had come through and been heard at the distant receiver, but no words had ever been understood. Moreover, and this is the significant point, the transmitter used in these earlier trials, and the transmitter described and illustrated in his patent of early 1876, was *not* a microphone type of transmitter, but was simply a receiver, of electromagnetic type, worked backward, now a familiar device in the physics laboratory. The discovery that a receiver can be so used originated with Bell. He is clearly the inventor of the

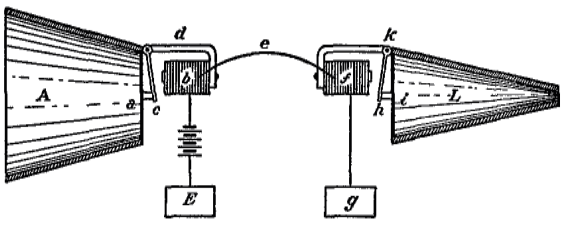


FIG. 3. Transmitter (left) and receiver (right) illustrated in Bell's first telephone patent, granted March 7, 1876.

electromagnetic type of transmitter. The point to be borne in mind is that his first successful telephone conversation was conducted, not with that type of transmitter, but with the so-called liquid transmitter, described by Watson, which can be recognized as a microphone type, the precursor, however rudimentary, of the modern transmitter.

That the transmitter which was described and illustrated in Bell's patent,[3] the application for which was filed on February 14 preceding his famous exploit of March 10 in the same year was not a microphone type, but an electromagnetic type (Fig. 3), the only drawing of a transmitter in Bell's patent constitutes an indication. The descriptive material accompanying it treats quite explicitly its construction and operation. It is also true, however, that Bell refers briefly in his patent to the possibility of a liquid transmitter, a reference confined to eight lines out of a total of about 190 printed lines. The legal status of this passing reference has never been clarified. To the lay mind, and especially regarded as a scientific accomplishment, it will be natural to feel that mere reference to a possible invention does not itself constitute an invention. That is all that can be said for Bell's claim to the liquid transmitter. Even from the legal side, moreover, it is well to note that Bell's later victories in litigation did not center in any claim that he may have made to the liquid transmitter. The main issue in all the suits in which this patent was involved was a different paragraph ("claim") not connected in any way with the liquid transmitter. So far from emphasizing the liquid transmitter, Bell explicitly stated his preference for the receiver type of transmitter in his application. Indeed, he thought so little of the liquid transmitter that he made no reference to it in another version of his patent

[2] For Bell's own account of this, see pp. 67–70 of *The Bell Telephone*, printed in 1908 by the American Bell Telephone Co. This is a reprint of Bell's deposition in connection with a suit once brought by the United States to annul Bell's patent. For Watson's account, see reference 1, pp. 66–71.

[3] No. 174,465 of Mar. 7, 1876, entitled *Improvement in Telegraphy.*

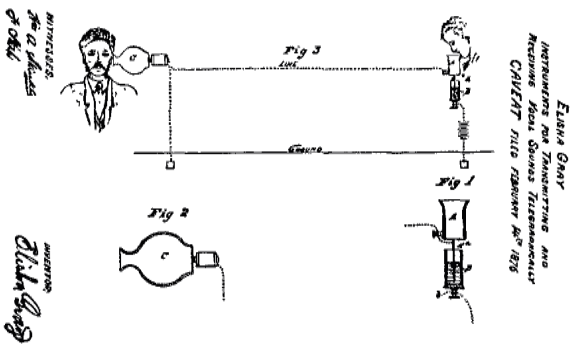


FIG. 4. Transmitter (right) and receiver (left) of Gray's caveat, filed the same day as Bell's application for a patent.

application, which he sent to England *after* he had written the American version, in the hope of securing foreign telephone patent rights as well.[4] So the transmitter into which Bell spoke on March 10, 1876 was not only not the instrument described and illustrated in his earlier patent, but it was not even the instrument of Bell's preference up to and indeed long after, his experiment of March 10, 1876.

The second thesis is that *the transmitter used by Bell on this famous occasion had previously been described by Elisha Gray, a free-lance inventor in the telegraphic field, in a confidential document about which Bell subsequently acknowledged having received information.* On the same day that Bell filed his application in the Patent Office in Washington, February 14, 1876, his principal competitor in the inventive field, Elisha Gray, filed another document, describing a telephone. Though Gray's description was fully as explicit and complete as Bell's, it was not technically an application for a patent. It was what was known as a *caveat*, a type of document which no longer exists in patent law, which was in essence a formal notice of intention to perfect and file a patent application. It gave the claimant documentary evidence of priority of an idea in event of subsequent disputes. There was no reason why the papers of Bell and Gray should not have been of the same type, both of them applications for a patent, or both caveats; the two men were on the same footing, neither having reduced to practice the idea which he was describing. But their legal advisers apparently had each his different mode of approach. As it proved, Gray was badly advised in submitting his idea in the form of a caveat. The legal technicalities involved in the two documents acted, in later court proceedings, to give Bell an enormous advantage which had no counterpart in any actual superiority or priority of his device. If both men had submitted the same type of document, whether caveat or application for a patent, the case could have been fought out on its merits instead of on the basis of a legal fiction. If Bell had submitted a caveat and Gray a patent application, thus reversing their positions before the law, we should, in all probability, have today the Gray Telephone Company in place of the Bell Telephone Company.

In addition to the difference in form, there was a difference in content of the two documents which was of even greater significance. Whereas Bell had made only parenthetical reference to the possibility of the liquid transmitter, devoting about one twenty-fifth of his application to it, Gray evidently considered the liquid transmitter to be of greatest importance. He described it in utmost detail, and illustrated it fully (Fig. 4). Half of his entire document was devoted to it. Gray's description covers the principle and many of the structural details of the transmitter made by Watson for Bell less than a month later. Fig. 5 is a photograph of a pair of the surviving models of Gray's instruments.

In pursuance of his official routine, the Patent Examiner notified Bell that his application came into conflict with a caveat which had been filed the same day. Since all such documents were confidential and the patent ethics of that time required that they remain so, the Examiner did not, of course, include in his notice to Bell any statement of the points at which the two claims interfered. Bell was acutely aware of the importance of his claims to invention of the telephone, doubtless feeling, and with the best of reason, as subsequent events have shown, that a fortune was at stake. Consequently he was deeply concerned at any possibility that this

[4] The English version was dispatched through one George Brown in the last week of January, 1876. Bell was always very vague about the date of his conception of the liquid transmitter, but his most direct statement on the point is to be found in *The Bell Telephone*, p. 87, where he sets it at "almost the last minute" before sending his patent application to Washington. This would probably have been about January 10–12, 1876. See also Catherine MacKenzie, *Alexander Graham Bell* (Houghton Mifflin, 1928), pp. 109–110.

fortune might elude his grasp. Apparently at the advice of his lawyer, he called on the Patent Examiner and asked to be informed about the nature of the interfering claims. Bell may have been entirely innocent in this move. Though he had had previous patent experience, he was not well versed in either the law or ethics of patent procedure, and may not have realized that he was asking for a breach of official confidence which would give him an unfair advantage over his competitor. He should, of course, have been instructed on this point by his lawyer. In any case, the only honorable course open to the Patent Examiner was to refuse to divulge the requested information. For some reason, however, he did not refuse. Pointing to the paragraph in Bell's application which mentioned the liquid transmitter, he told him that there was an interference at that point. What led him to do this we shall probably never know. The fact that he did it has been established by Bell's own repeated admissions in court.[5] The Examiner never appeared in court to deny it, nor did he ever make any denial outside of court. The fact that Bell received this information is completely authenticated.

Statements have been made and evidence offered to the effect that the Examiner went much further than this, allowing Bell an extended examination of Gray's caveat.[6] The allegation seems not to have been adequately proven, though it has certainly never been conclusively disproven. In any case, it is relatively unimportant. If the Examiner gave no more information than that which Bell admits having received from him, he violated the responsibility of his office. In doing so, he gave Bell just the information that would spur him to the step that he next took, construction and use of the device that his competitor had described, but never made. There is no suggestion anywhere that up to this time Bell had ever made, or contemplated making a liquid transmitter. Yet he immediately recalled his assistant, Watson, whom he had previously laid off, and through feverish activity on the part of the two, succeeded in making and successfully using a liquid transmitter within less than two weeks of the time that he received information about it through the Patent Examiner. Thus not only had Bell's transmitter, made by Watson and first used on March 10, 1876, been previously described and the description come to Bell's knowledge, but the subsequent occurrences indicate that he made good use of the information, without which his first successful use of a telephone would at least have been considerably delayed.

The third thesis is that *it was not until four years later that Bell made any claim to the type of transmitter into which he spoke on that historic occasion.* The first successful transmission of speech in America by means of electricity was an historic event. Bell might have been pardoned, indeed, he would have been fully justified, in publishing it far and wide. Today it is universally considered the most dramatic episode in the history of the telephone. It is somewhat of a shock, therefore, to discover both that Bell did not at that time make any announcement of his accomplishment and that for several years he apparently made every attempt to conceal it. Some of the principal occasions when, having an opportunity to tell of that now famous episode, he nevertheless refrained from doing so, will be recounted presently. In the meantime it may be

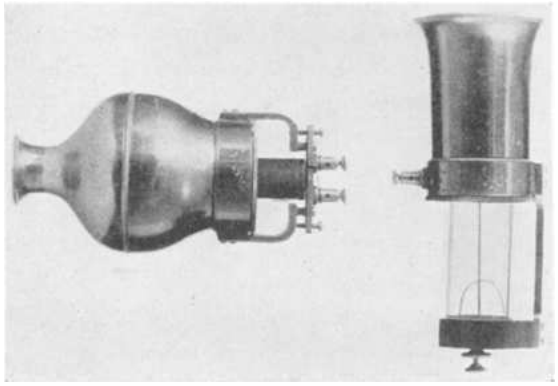


FIG. 5. Surviving models of Gray's receiver and transmitter.

[5] For example, see *Dowd Case Record* (Circuit Court of U. S., Dist. of Mass., 1880), I, 529–531; *The Bell Telephone*, p. 434.

[6] A long affidavit to this effect by Zenas F. Wilber, examiner in charge of electrical applications in the Patent Office during the interval in question, was published in *The Washington Post* of May 22, 1886. The original autograph copy of this affidavit is in the author's possession. This affidavit named five witnesses to the alleged conference and contained statements which, if untrue, could have formed the bases of several suits for libel. No such suit was ever instituted. Bell published a denial of Wilber's allegations in the May 25 issue of *The Washington Post*, and there the matter was allowed to rest.

observed that if he was to conceal the incident and yet claim the distinction of having been the first to talk over a telephone of his own make, he must reproduce the incident, using an instrument which he felt he could claim. This he prepared immediately to do. He set about the task of so modifying the receiver type of transmitter described in his patent that it would transmit speech, and within three or four weeks he was successful, in a second episode which deserves to rank with that of the preceding tenth of March.[7]

Having so altered the telephone of his patent that it could be made to speak, Bell was then in a position to make public announcement of his accomplishment of the electric transmission of speech and to demonstrate it without using a liquid transmitter. This he did in two important public lectures in the late spring of the same year, one before the American Academy of Arts and Sciences on May 10 and one before the Society of Arts at a meeting held at the Massachusetts Institute of Technology on May 25.[8] Bell may have had his liquid transmitter with him on these occasions, or even shown it to his audiences, though there is nothing in the printed record of his lectures to indicate that he did.[9] Bell himself, when testifying a few years later, could not recall whether he had the liquid transmitter with him on those occasions.[10] In any case, he did not demonstrate it in operation, though he did demonstrate his receiver-type instruments.

Bell must have felt very insecure about any claim which he could make to the liquid transmitter, for he continued for a long time this policy of secretiveness about his now famous experiment of March 10, 1876. An unprecedented opportunity for bringing his accomplishment to public notice presented itself in the Centennial Exhibition at Philadelphia in the same year. His demonstrations there, as in the case of his lectures, were confined to his receiver type instruments. Though he had a model of the liquid transmitter there, he did not use it.[11] Moreover the judges make no mention of any liquid transmitter in their official reports of Bell's exhibits, though they describe his receiver type instruments in detail.[12]

In the trial of the Dowd case, the only occasion when the claims of Bell and Gray came directly into conflict in court, at no time, during his entire nine days on the stand did Bell even mention his first transmission of speech on March 10, 1876, when a liquid transmitter was used.[13] In his patent of January 30, 1877,[14] on *Improvement in Electric Telegraphy*, when, if ever, he would be expected to consolidate all improvements in the telephone to which he was entitled, Bell reiterates his preference for receiver type transmitters but refers very guardedly to the possibility of other types, in these words:

> I have heretofore described and exhibited such other means of transmitting sound, as will be seen by reference to the proceedings of the American Academy of Arts and Sciences, Volume XII.

It should be noted that he merely "described and exhibited" another type of transmitter. There is no claim to having invented it, either in the foregoing extract, nor in the article to which it refers.

It seems clear that, at least during the first four years of the telephone, Bell did not feel justified in claiming the liquid transmitter. Not until after the settlement of the Dowd case in 1879, by compromise between the contending parties, one of the terms of which was a division of all telephone royalties between them during the life of the patents in suit,[15] did Bell begin to feel at all secure in his position with reference to the liquid transmitter. It was in 1880 that Bell made his first attempt to claim priority in conceiving it.[16]

Bell's skill as a tactician reaped its full reward. During the crucial period of the struggle for supremacy, Gray and his advisers were completely misled. Gray was present at Bell's Cen-

[7] *The Bell Telephone*, p. 379; *American Bell Telephone et al. vs People's Telephone Company*, I 324–325, II 1653.
[8] *The Bell Telephone*, pp. 95–96.
[9] A. Graham Bell, "Researches in Telephony," Proc. Am. Acad. Arts and Sci., Vol. XII, first paper.
[10] *The Bell Telephone*, p. 95.
[11] *Dowd Case Record*, I 494, 544; *United States Supreme Court Reports*, Vol. 126, p. 323; *The Bell Telephone*, p. 100.
[12] *Dowd Case Record*, I 167–171, II 31–35.
[13] *Dowd Case Record*, I 440–534.
[14] Patent No. 186,787 by A. G. Bell.
[15] Affidavit of George Gifford. Department of the Interior; in the Matter of the Petition for Leave to Bring a Suit in the Name of the United States to Cancel Patent No. 174,466, Issued March 7, 1876, to Alexander Graham Bell. American Bell Telephone Company. p. 16.
[16] *American Bell Telephone Company vs. People's Telephone Company*, 1880. Repeated in *The Bell Telephone*, pp. 83–88.

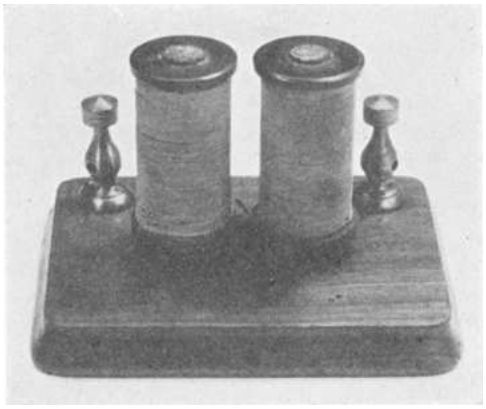


FIG. 6. Gray's first electromagnetic receiver.

tennial exhibition but did not see any liquid transmitter.[17] Had he seen it he would, of course, have instantly recognized it as his own and proceeded accordingly. Not knowing of its existence, he became convinced that he must concede priority to Bell because he supposed that the first successful performance of the telephone at Bell's hands had been with a transmitter quite different from his own. Gray summarized the case, in a letter written just before his death, in these words:

> It was not till eight or ten years—at least a long time after the telephone was in use—that I became convinced, chiefly through Bell's own testimony in the various suits, that I had shown him *how* to construct the telephone with which he obtained his first results.[18]

With this brief summary of the evidence that Bell made no claim to the microphone type of transmitter until four years after the time of his first experiment with it, we turn from consideration of the part played by the transmitter in the telephone contest to the part played by the receiver. Gray's priority is perhaps even more pronounced here than with the transmitter, for, as will be adduced presently, he had unchallengeable patent priority on this point. Legal precedence is not the point at present under emphasis, however. It is rather the relative actual accomplishment of the two men, which is often quite distinct from mere legal advantage. The fact in connection with this part of the telephone contest is that *Elisha Gray had made and publicly used several types of telephone receiver many months before Bell constructed his first one.*

There are many ways in which the fluctuating electric currents that carry telephone messages from one place to another can be converted back into sounds resembling the sounds that created them. But of all the ways that are possible, the one that has almost universally prevailed in practice is to cause the fluctuating currents to act upon a diaphragm, especially a metal diaphragm, through the agency of an electromagnet. Through all its variations, the telephone receiver has embodied this principle almost exclusively. Any inquiry, therefore, into precedence in development of the telephone receiver, as between Bell and Gray, must center on the question of which of the two first developed and used the combination of an electromagnet and

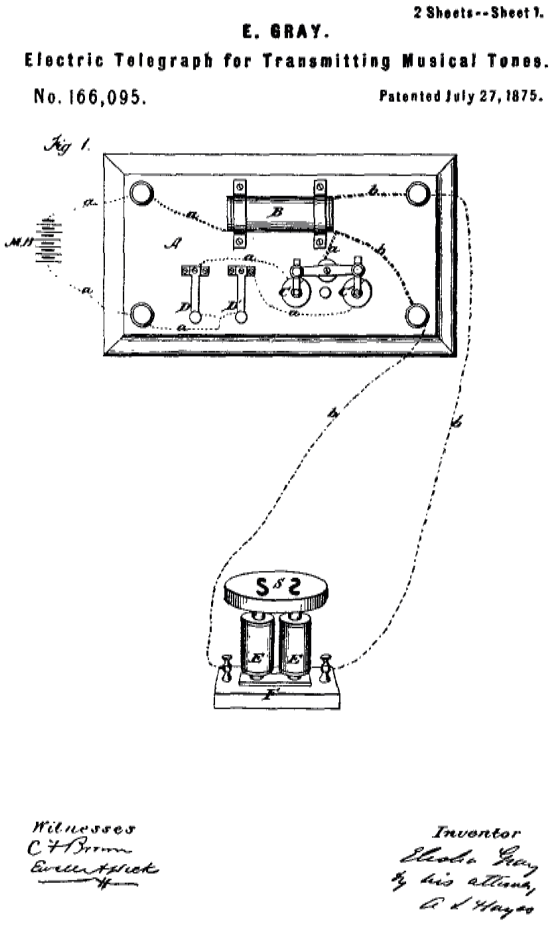


FIG. 7. Gray's first receiver, connected to reproduce the musical tone from a buzzer; taken from his American patent of 1875.

[17] *Dowd Case Record*, I 126–127.

[18] Letter from Gray, published in *The Electrical World and Engineer*, Feb. 2, 1901, p. 199.

FIG. 8. Gray's second receiver.

diaphragm, especially an electromagnet and metal diaphragm, to produce sound electrically.

Aside from Bell's use of one of his unmodified harmonic telegraph instruments as a makeshift receiver, his first attempt to construct an electromagnetic telephone receiver was in the summer of 1875, in an episode which is justly considered to be nearly as significant as his first experiment with the prototype of the modern transmitter in 1876. The diaphragm of this first receiver was of parchment however, not metal. This is the instrument of Fig. 2. The first occasion upon which Bell publicly demonstrated a receiver possessing a metal diaphragm was the Centennial exhibition in Philadelphia in June, 1876, a year later.

But while it is impossible to attribute to Bell the development of the telephone receiver earlier than June 1875, Elisha Gray had constructed and publicly demonstrated, as early as 1874 and before February 1875, not less than four receivers which were prototypes of the modern telephone receiver. Each one of these consisted of a pair of electromagnets, near the end of which was placed a diaphragm of some form. The receivers differed from each other primarily in the variations in this diaphragm.

Gray's first electromagnetic receiver is shown in Fig. 6. This instrument was given to Oberlin College by Elisha Gray personally, some time during the eighties, at which time he made a statement of its history. The diaphragm, originally an ordinary shoe-blacking box supported near the poles of the electromagnet, has been lost sometime during the intervening years. The way the instrument was used is shown in Fig. 7. It was made in May 1874 and was used during the same month in demonstrations in Boston, New York and Washington before a number of officials and directors of telegraph companies and in the presence of representatives of the Smithsonian Institution and the United States Naval Observatory.[19] This receiver was patented in England in July 1874 and in the United States in July 1875, nineteen months and seven months respectively before Bell's patent of 1876.

Gray's second receiver (Fig. 8) was made in Chicago in July 1874 and shown in operation in the same month and in the following month. Gray took it to England with him that same autumn and publicly demonstrated it there, showing it, among others, to Professor Tyndall at the Royal Institution in London.[20] A number of these receivers were made, two of which are in existence today. The original model is in the possession of the Smithsonian Institution.

Gray's third receiver was the progenitor of the modern loudspeaker. The receiver proper, including a metal diaphragm, was mounted upon a wooden sounding box which acted as a resonator (Fig. 9). The original is in possession of the Smithsonian Institution. This receiver was made in December 1874, and used in the same month in a public demonstration in the Presbyterian Church at Highland Park, Illinois.[21]

Gray's fourth receiver constituted another attempt to utilize resonance as a means of amplifying sound, but in a smaller and more sensitive instrument, capable of use on longer lines than the wooden sounding box type was designed for. It was used for the first time in February 1875 on a line between Chicago and Milwaukee.[22] It is illustrated in Fig. 10, taken from the record of the Dowd case. The original model has not survived. This is regrettable,

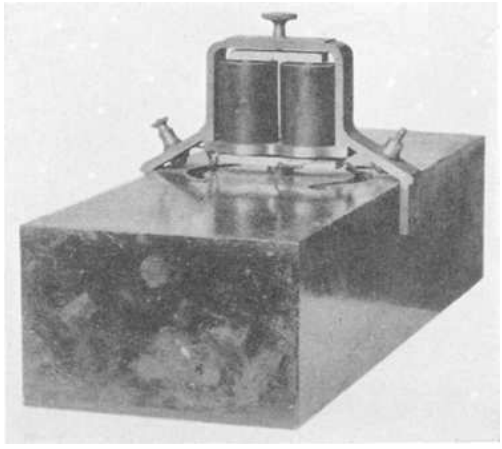


FIG. 9. Gray's third receiver.

[19] *Dowd Case Record*, I 74, 119.
[20] *Dowd Case Record*, I 74–76, 81, 114–116, 155–156.
[21] *Dowd Case Record*, I 86.
[22] *Dowd Case Record*, I 87–88, 122, II 770.

since it came closer to the conventional form of telephone receiver as it later developed than did any of the previous forms.

It is evident, from the documentation on the foregoing receivers, that, during the year preceding the earliest date that Bell can claim, Gray had made and exhibited to some hundreds of witnesses who were qualified to comprehend their principle and importance, four types of telephone receiver, all of which possessed thin metal diaphragms and hence anticipated the design of the modern telephone receiver much more closely than did the receiver which Bell first devised in 1875. But even these four were not his first successful ventures in this field. He had made, used, and published descriptions of at least three others prior to any of these four.[23] But since the earlier models acted on a principle which could not have produced the modern receiver, they are not included here.

It should be understood that the tests and demonstrations made with these receivers during 1874 and 1875 involved only the production of musical tones from intermittent currents produced by tuned buzzers in the circuits. This was not because the receivers were incapable of reproducing speech, for three out of the four were capable of reproducing speech excellently, as later tests showed.[24] That Gray had a strong suspicion that his receivers possessed this ability is made clear by his testimony before the Patent Commissioner,[25] but it was not possible for him to test their ability to reproduce speech because at that time no method was known for getting speech *into* an electric system to be so reproduced. This had to await the invention of the transmitter.

[23] *Speaking Telephone Interferences, Elisha Gray's Case.* United States Patent Office, 1880, pp. 6, 9, 10, 42, 61, 62, 63; *Dowd Case Record,* I 72, 73, 74, II 678, 763, 765; G. B. Prescott, *The Speaking Telephone* (Appleton, ed. 1, 1878), pp. 155, 188, 193; *Scientific American Supplement,* Feb. 5, 1876, p. 92; Gray's patents No. 166,096 of July 27, 1875 and No. 210,776 of Dec. 10, 1878.

[24] *Dowd Case Record,* I 92–94, 180, 183, 229, 261.

[25] *United States Patent Office,* 1888. Gray's "Petition before Commissioner of Patents," pp. 44–45.

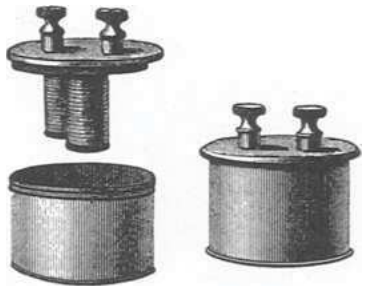


FIG. 10. Gray's fourth receiver.

For some reason, Gray's priority in the development of the telephone *receiver* has been allowed to escape general notice. That story has now been told. As for the *transmitter,* the story of how he was maneuvered by Bell and Bell's associates out of the maintenance of his proper claim to priority in design of the microphone type of telephone transmitter has also now been told. Gray's loss of credit for these two major contributions to the development of the telephone was quite possibly due in part to his own ineptitude as a tactician. As to the facts of his priority in both fields there is little room for controversy. The curious popular interpretation of those facts which gives exclusive credit to Bell for designs previously recorded and devices previously constructed by Gray is, alas, all too typical of common practice throughout the whole history of electrical communication.[26]

After Gray's death, a scrap of paper was found among his belongings,[27] on which he had written in his quaint scrawl, during some moment of profound discouragement, the following epitaph on the telephone contest:

> *The history of the telephone will never be fully written. It is partly hidden away in 20 or 30 thousand pages of testimony and partly lying on the hearts and consciences of a few whose lips are Sealed,—Some in death and others by a golden clasp whose grip is even tighter.*

[26] For an apt and informed statement on the pronounced trend in this direction during the entire history of electrical communication see *Old Wires and New Waves,* by Alvin Harlow (D. Appleton-Century Co., 1936), p. 162.

[27] Original autograph copy in the author's possession.